

III.—*Note on Fossil Woods and other Plant Remains, from the Cretaceous and Laramie Formations of the Western Territories of Canada.* By SIR WILLIAM DAWSON, F.R.S.

(Read May 25, 1887.)

Silicified wood and lignite, retaining structure, are known to exist at different horizons in the Upper Cretaceous beds of the Northwest, in the Laramie formation, and in the Lower Miocene of the Cypress Hills, and loose fragments of these woods are not infrequent in the drift or on the surface. Hence the numerous specimens, collected by travellers and explorers, are of little palaeontological value, except when they have been found in place, and when the geological ages of the beds containing them have been ascertained. When their relations in this respect are known, they are, however, of much interest, more especially when compared with the other plant remains found in the Cretaceous and overlying beds. I have, for this reason, endeavoured to collect and study these different species of wood, and now present a short account of them, as a supplement to my paper of last year on the Laramie flora.

A number of specimens of these woods, principally from the Laramie beds, were collected by Dr. G. M. Dawson, when acting as Geologist to the Boundary Commission. They were placed in my hands for examination, and were described and some of them figured in the Report of the Survey of the 49th Parallel (1875).¹ They were principally coniferous, and represented in all about nine species, which, following the classification proposed by Kraus in Schimper's "Palæontologie," were referred to the genera *Cedroxylon*, *Pitoxylon*, *Cupressoxylon* and *Taxoxylon*. There was also ordinary exogenous wood of the type of that of the poplars.

In 1868, Cramer described in Heer's "Flora Fossilis Arctica," a number of specimens of coniferous wood from Greenland, Banks Land, and Spitzbergen, which he referred to *Cupressoxylon* and *Pinite*; and a species of *Betula*. In 1880, Schroeter, in the same publication described some fossil woods from the Laramie of Mackenzie River, under the names *Sequoia Canadensis*, *Ginkgo*, sp., and *Platanus aceroides*. The first of these species is somewhat near to *Sequoia sempervirens*, the Californian Redwood, and may not unreasonably be supposed to be the wood of *Sequoia Langsdorffii*, a species found with it, and which in foliage resembles the Redwood.

I have now been enabled to secure slices of about sixty distinct trees, most of them *in situ*, and from the horizons of the Belly River, Fort Pierre, and Laramie groups. These have been collected principally by Dr. G. M. Dawson, Mr. J. B. Tyrrell and Mr. T. C. Weston, and, with the exception of a few prepared in the Peter Redpath Museum, have been sliced by Mr. Weston.²

¹ Appendix, p. 331.

² The slices prepared by Mr. Weston will be deposited in the Museum of the Geological Survey at Ottawa.

In describing them I shall follow the order of geological age, and shall refer the specimens to their probable genera without giving them any specific names, as it seems in every way likely that most of them belong to species otherwise named from specimens of their leaves and fruit. I shall append to this paper a few notes on recent discoveries of Laramie plants, some of which are closely connected with those described in the body of the paper. It may be added, that I have found the classification and nomenclature of the coniferous woods proposed by Goeppert, Kraus, Schroeter and others very imperfect and misleading; and I agree with Kraus and Schimper, in holding that no specific, or even generic distinctions can be made with absolute certainty, on the evidence of structure alone. In these circumstances, I have thought it best to compare the structures of the fossil woods with those modern forms which they appeared most to resemble, and especially with those represented by the leaves and fruits found in the same beds. In this way, at least, certain facts will be indicated which may ultimately enable the trunks, known by their structure, to be associated with the other parts of the same trees. As presented in this paper, however, the attainment of this desirable result must be regarded as tentative merely and necessarily imperfect. The exogenous woods examined have been treated in a similar manner; but as these are often even less perfectly preserved than the conifers, the results are liable to the same uncertainties.

I.—BELLY RIVER AND FORT PIERRE SERIES.

The Belly River beds, which contain many fossil plants and important beds of coal, are believed, on stratigraphical grounds, to underlie the Fort Pierre series, which is marine. (See note in my paper in these Transactions, Vol. IV, 1886). The flora of the Belly River series is, however, very similar to that of the Lower Laramie above the Fort Pierre series, and the trunks of drift trees found in the latter, and referred to below, seem to some extent to connect the two. The greater number of the woods in these formations are coniferous; but there are some exogens, most of which are from drift trunks in the Fort Pierre group, while many of the conifers are from beds near to the coal deposits of the Belly River district.

All these woods, whether coniferous, or angiospermous, have distinct annual layers of growth.

Conifers.

SEQUOIA.—Type of *S. gigantea*, the "big tree" of California. Wood with wide woody fibres, having large bordered pores in one row, and narrow, simple medullary rays of many rows of cells superimposed. Resin tubes large, but not numerous. Pierre group, Bow River (G. M. Dawson); Belly River series, Ribstone Creek (J. B. Tyrrell); Belly River series, white rocks above coal bank (T. C. Weston); Belly River series, Ribstone Creek (T. C. W.); west of Medicine Hat (J. W. D.)

SEQUOIA.—Type of *S. sempervirens*, the "Redwood" of California. Wood with wide, woody fibres, having usually small, bordered pores in two series. Medullary rays, simple or complex, of many rows of cells superimposed; distinct resin tubes. Belly River series, Ribstone Creek (J. B. T.); Belly River series, white rocks above coal bank (T. C. W.), three specimens; Saskatchewan River (Dr. Selwyn.)

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TAXITES.—Type of *Taxus baccata*, or of *Torreya*, and other yews. Wood with narrow fibres, having discs in one row and numerous spiral lines. Belly River series, South Saskatchewan (G. M. D.)

GINKGO or SALISBURYA.—Type of *S. adiantifolia*, the Chinese Ginkgo tree. Wood with moderately narrow fibres, having bordered pores in one row, and numerous, very short, medullary rays, having usually only two rows of cells superimposed. The woody fibres sometimes show spiral lines, but much less distinctly than in the previous species. This wood is quite similar to that of the Chinese Ginkgo. South Saskatchewan, Belly River series (G. M. D.); west of Medicine Hat (J. W. D.) Similar wood occurs in the Laramie series.

THUJA.—Type of *S. occidentalis*. Belly River series, Oldman River (G. M. D.); Belly River series, Ribstone Creek (J. B. T.); Twenty Mile Creek (J. W. D.)

PINUS, or ABIES (?)—Type of *Pityxylon* of author, with frequent, short, medullary rays, and many resiniferous tubes, and one row of bordered pores. West of Medicine Hat (J. W. D.)

Exogens.

The generic names attached to these woods merely indicate a close resemblance to the genera named, in the nature and arrangement of the tissues, so far as ascertained.

BETULA.—Belly River series, Ribstone Creek (J. B. T.); Fort Pierre series, head of Swift Current (T. C. W.)

POPULUS.—Fort Pierre series, head of Swift Current (T. C. W.)

CARYA.—Fort Pierre series, head of Swift Current, two specimens (T. C. W.)

ULMUS.—Fort Pierre group, same locality (T. C. W.)

PLATANUS (?)—Belly River series, Ribstone Creek (T. C. W.)

The above woods are all Upper Cretaceous. With reference to the genus *Sequoia*, it may be noticed that foliage of a species of this genus, referred to *S. Reichenbachii*, is exceedingly abundant in the shales associated with the coal on the Belly River, and also on the South Saskatchewan.

With respect to the abundance of exogenous stems relatively to the number of exogenous leaves found in the Belly River and Fort Pierre series, it is to be observed that, in a marine series like the Fort Pierre, drift trunks are much more likely to occur than leaves. It is also to be observed that leaves of *Populus* and *Platanus* occur in the Belly River series near Medicine Hat, and that most of the genera represented by the woods, occur in the Middle or Upper Cretaceous of the Peace River district and of Vancouver Island.

II.—LOWER LARAMIE SERIES.

From this formation there are only five specimens in the collection. Three of these, collected by Mr. Tyrrell and Dr. Dawson at Antler Hill and Edmonton, have the structure of *Sequoia*, one that of *S. gigantea*, two that of *S. sempervirens*. Another specimen shows a taxine structure with short, medullary rays similar to that of *Salisbury* noticed above. The fifth is probably a *Thuja* or *Arbor vitæ*. It was collected by Mr. Weston in Scabby Creek.

III.—UPPER LARAMIE SERIES.

Conifers.

SEQUOIA.—Type of *S. gigantea*. Wood End Depot (G.M.D.); Côteau, in drift (G.M.D.); Mackenzie River (Geol. Survey); two specimens.

SEQUOIA.—Type of *S. sempervirens*. Turtle Mountain (G.M.D.); Lignite, Souris Valley (G.M.D.); Middle Lignite, 245 Mile Valley (G.M.D.); Lignite, Wood End Depot (G.M.D.); Mackenzie River (Geol. Survey); thick bed of Lignite, Edmonton (G.M.D.)

TAXITES.—Type of *S. baccata*. Red Deer River (J. McKenzie), in Redpath Museum; Wood End Depot (G.M.D.)

GINKGO.—With short medullary rays as above, under Section I. Souris River four miles west of St. Mary's River (G.M.D.); Mackenzie River (Geol. Survey).

THUJA.—400 Mile Point, 49th parallel (G. M. D.); L. 29, R. 13 W. (J. B. T.); Middle Fork, Oldman River (J. B. T.)

PINUS (?)—Some drift specimens in the collections of Dr. G. M. Dawson shew structures resembling those of *P. Banksiana*, the scrub pine. Leaves referable to a pine of this type, occur in the Mackenzie River beds, according to Heer.

Exogens.

These are specimens (T.C.W.) from Souris River, shewing the structure of *Juglans*, and from the same place (T.C.W.), having the structure of *Betula*.

In a series of specimens from Swift Current (T.C.W.), which I suppose belong to the Laramie horizon, there are structures resembling those of *Juglans*, *Populus*, *Acer* and *Betula*.

It is to be observed that, in addition to the specimens of silicified wood, shewing the structure of *Sequoia*, similar structures occur in specimens of the lignites, when treated with caustic potash or with nitric acid, and that leaves and cones of *Sequoia*, both of the *gigantea* and *sempervirens* types, are among the common fossils of the shales and sandstones. The occurrence of taxine woods in like manner, connects itself with the leaves and branches of *Taxites Otkiki*, Heer, and *T. occidentalis*, Newby, and with nuts and leaves of *Ginkgo*, and that of *Thuja* with the plentiful remains of *T. interrupta*, Newby. In like manner, the exogenous woods represent several of the genera whose leaves are common in the clays and shales.

IV.—ADDITIONAL LARAMIE AND BELLY RIVER PLANTS.

Since the publication of my paper on the Laramie flora, I have examined an interesting collection from the Belly River series, and the Lower and Upper Laramie, made by Mr. J. B. Tyrrell, which includes the following species, either new to our fossil botany or from new localities.

ONOCLEA SENSIBILIS, Lin.—North Saskatchewan, west side, Upper Laramie.

SEQUOIA LANGSDORFFII, Heer.—North Saskatchewan, Rocky Mountain House, Upper Laramie. As stated in my previous paper, I fail in separating the foliage of this species from that of *S. Nordenstkioldii*, Heer, to which I have referred some specimens noticed in that paper.

S. COUTTSIAE, *Heer*.—Same locality, Upper Laramie.

PODOCARPITES TYRRELLII, S.N.—Vermilion River, Belly River series. Fruit globular, flattened, with thin coaly testa, marked with faint, interrupted striae. Diameter, 9 mm. Obscure, pinnately attached leaves, resembling those of *Podocarpus incerta* of the English Eocene are found with these fruits, and probably belonged to the same species. This is the first appearance of the genus *Podocarpus* in our Upper Cretaceous. It is, however, well-known in the European Eocene, and one species is recorded by Lesquereux from the Tertiary of the United States.

POPULUS ARCTICA, *Heer*.—Many large and fine leaves, North Saskatchewan, west side, Upper Laramie. This may be the same with *P. cuneata*, Newberry.

P. GENETRIX, *Newby*, or allied.—Same locality, Upper Laramie.

P. NERVOSA (?)—Rocky Mountain House, Upper Laramie.

SALIX LARAMIANA, *Dn*.—Same locality, Upper Laramie.

CARYA ANTIQUORUM, *Newby*.—Same locality, Upper Laramie.

NELUMBINUM SASKATCHUENSE, S. N.—Leaves orbicular, peltate, with seven nerves. Substance apparently thick and coriaceous. Diameter, two centimetres, or a little more. The reference of these leaves, which are imperfectly preserved, to *Nelumbium*, is not certain. They are, in any case, peltate, aquatic leaves, different from those of *Brasenia antiqua*, described in the previous paper.

TRAPA BOREALIS, *Heer*.—Leaves and fruit, Vermilion River. Belly River series. The leaves are the same with Lesquereux's *T. microphylla*.

VIBURNUM SASKATCHUENSE, S. N.—North Saskatchewan, east side, Upper Laramie. These leaves are unusually broad, and with the veins well marked and less remote than in any of the other species I can find described. The species may be thus characterised:—Leaf thick, coriaceous; broad-ovate, acuminate pointed, somewhat cordate at base; ordinary length about three inches. Margin sharply and equally toothed. Midrib central and strong. Veins strongly marked, at an acute angle to midrib, straight and forking once or twice at their extremities, close together (about $\frac{1}{6}$ inch). The direction of the veins leaves a broad doubly-veined lower margin, with curved veins, the upper and principal series five or six, and forking, the lower series short, much curved, and some of them forking. Nerves very close, fine and numerous, and angled or netted in the space between the veins. These leaves, of which there are several well preserved specimens in Mr. Tyrrell's collections, resemble in form some varieties of *V. tilioides*, Ward, and in the venation *V. Nordenskioldii*, Heer.

VIBURNUM ASPERUM, *Newby*.—Same locality, Upper Laramie.

SAPINDUS, Sp.—Leaves small, short, unequally ovate, slightly acuminate. Midrib distinct. Veins few, at a very obtuse angle. Margin entire. This leaf is very near to *S. obtusifolia* of Lesq., and may be the same. Lesquereux's specimens are from the "Carbon group," which is supposed to be later than the Laramie.

V.—CONCLUDING REMARKS.

While studying the specimens described on this paper, I received the volume of the Palaeontographical Society for 1885, containing the conclusion of Mr. Starkie Gardener's description of the Eocene coniferæ of England. The work which he has been able to do,

in disentangling the nomenclature of the plants and fixing their geological age, is of the greatest value, and shows how liable the palæobotanist is to fall into error in determining species from imperfect specimens. Our American species, no doubt, require some revision in this respect.

I have, also, while writing out the above notes for publication, received the paper of same author on the Eocene beds of Ardtun, in Mull, and am fully confirmed thereby in the opinion derived from the papers of the Duke of Argyll, and the late Prof. E. Forbes,¹ that the Mull beds very closely correspond in age with the Laramie. The *Filicites Hebridica*, of Forbes, is our *Onoclea sensibilis*. The species of *Ginkgo*, *Taxus*, *Sequoia* and *Glyptostrobus* correspond, and we have now probably found a *Podocarpus*, as noted above. The *Platanites Hebridica* is very near to our great *Platanus nobilis*. *Corylus Macquarrii*, is common to both formations; as well as *Populus arctica*, and *P. Richardsoni*, while many of the other exogens are generically the same, and very closely allied. These Ardtun beds are regarded by Mr. Gardener as Lower Eocene, or a little older than the Gelinden series of Saporta, and nearly of the same age with the so-called Miocene of Atanekerdruk, in Greenland. Dr. G. M. Dawson and the writer have, ever since 1875, maintained the Lower Eocene age of our Laramie, and of the Fort Union group of the Northwestern United States, and the identity of their flora with that of Mackenzie River and the upper beds of Greenland, and it is very satisfactory to find that Mr. Gardener has independently arrived at similar conclusions with respect to the Eocene of Great Britain.

An important geological consequence arising from this is, that the period of warm climate, which enabled a temperate flora to exist in Greenland, was that of the later Cretaceous and early Eocene, rather than, as usually stated, the Miocene. It is also a question admitting of discussion whether the Eocene species of latitudes so different as those of Greenland, Mackenzie River, N. W. Canada and the Western States, were strictly contemporaneous, or successive within a long geological period in which climatal changes were gradually proceeding. The latter statement must apply at least to the beginning and close of the period; but the plants themselves have something to say in favour of contemporaneity. The flora of the Laramie is not a tropical but a temperate flora, showing no doubt that a much more equable climate prevailed in the more northern parts of America than at present. But this equability of climate implies the possibility of a great geographical range on the part of plants. Thus, it is quite possible, and indeed highly probable that, in the Laramie age, a somewhat uniform flora extended from the Arctic seas through the great central plateau of America, far to the south, and in like manner along the western coast of Europe. It is also to be observed that, as Gardener points out, there are some differences indicating a diversity of climate between Greenland and England, and even between Scotland and Ireland and the South of England, and we have similar differences, though not strongly marked, between the Laramie of Northern Canada and that of the United States. When all our beds of this age, from the Arctic sea to the 49th parallel, have been ransacked for plants, and when the palæobotanists of the United States shall have succeeded in completely unravelling the confusion which now exists between their Laramie and the Middle Tertiary, the geologist of the future will be able to restore with much certainty the distribution of the vast forests which, in the early Eocene, covered the now

¹ Journal of the Geol. Soc., London, vol. vii.

bare plains of interior America. Further, since the break which, in Western Europe, separates the flora of the Cretaceous from that of the Eocene, does not exist in America, it will then be possible to trace the succession of plants all the way from the Mesozoic flora of the Queen Charlotte Islands and the Kootanie series, described in previous papers in these Transactions, up to the close of the Eocene, and to determine, for America at least, the manner and conditions under which the angiospermous flora of the later Cretaceous succeeded to the pines and cycads which characterised the beginning of the Cretaceous period.

NOTE.—While the above paper was passing through the press, I received the "Synopsis of the Flora of the Laramie Group" and "Types of the Laramie Flora," by Mr. Lester F. Ward, which are very valuable contributions to the literature of this subject. In the former, Mr. Ward establishes, by a careful discussion and tabulation of the species, the fact that the Laramie flora has close relations with that of the Upper Cretaceous on the one hand, and that of the Eocene on the other, and that the Fort Union group constitutes its upper member and more northern representative. In this he agrees, on the one hand, with Cope, White and other zoological paleontologists, and on the other with the conclusions long ago stated, in so far as Canada is concerned, by Dr. G. M. Dawson and the writer. This memoir, in short, may be considered as conclusive on these points, so far as the United States geologists are concerned. Mr. Ward states his final conclusions as follows:—

"It is wholly immaterial whether we call the Laramie Cretaceous or Tertiary, so long as we correctly understand its relations to the beds below and above it. We know that the strata immediately beneath are recognised as Upper Cretaceous, and we equally know that the strata above are recognised as Lower Tertiary. Whether this great intermediate deposit be known as Cretaceous or Tertiary is therefore merely a question of a name, and its decision one way or another cannot advance our knowledge in the least."

Geologists may perhaps take exception to the small value attached to stratigraphical names and classification by the paleobotanist; but they will hail with pleasure his decided conclusions as to the evidence of the flora with regard to the position of this much disputed formation. I may add here that the facts adduced by Mr. Ward show the existence in the United States of the same distinction between Upper and Lower Laramie observed in Canada, and that the lower member seems there to be richer in plants than it has yet proved to be in this country.

In his later memoir, Mr. Ward discusses some points of interest with reference to the Laramie series. One only of this requires notice here at present. He establishes as a distinct species the auriculate specimens of *Platanus nobilis*, under the name *P. basilobata*. I confess I doubt this, as, in the numerous specimens in my collections and those of the Geological Survey, some possess and others want the basal lobes without shewing any other difference, and the basal lobes are often wanting or concealed in the matrix when traces remain to show that they were present. Mr. Ward's own observations with regard to the occasional presence of such lobes in the modern American *Platanus* agree with this.